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Port Ellen Terminal Development
Appendix D.11
Addendum to Underwater Noise Assessment

Project:	Port Ellen Terminal Development		
Subject:	Addendum to Underwater Noise Assessment		
Our reference:	115031-MMD-PE-XX-RP-O-0025	**Date:**	February 2026
Prepared by:	Acoustic Engineer	**Checked and approved by:**	Technical Director

1 Introduction

This addendum to the *Volume 3 Technical Appendices, Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment* has been prepared to outline recent proposed updates to the construction methodology. These updates include revised hours of operation for backhoe dredging and the disposal of dredge material at the Port Ellen disposal site (MA030) rather than the disposal site at Portnahaven (MA035). The addendum focuses on elements that have changed while all assessments and impacts related to unchanged construction activities remain consistent with the previous underwater noise assessment.

1.1 Policy context, legislation, guidance and standards

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 1.1*.

1.2 Glossary

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 1.2.*

1.3 Consultation

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 1.3*.

2 Methodology

2.1 Identification of marine acoustic thresholds

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.1*.

2.2 Study area

2.2.1 Baseline

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.2.1*.

2.2.2 Changes to baseline during construction

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.2.2*.

2.2.3 Zone of Influence (ZoI)

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.2.3*.

2.2.4 Identified marine receptors within ZoI

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.2.4*.

2.3 Underwater noise model

2.3.1 Underwater noise model parameters

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.3.1*.

2.3.2 Construction noise levels

The construction noise levels were obtained from best available technical information from previous projects and literature. These are compared with the latest engineering design methodology to determine the predicted source levels.

Since the completion of the previous technical appendix, the construction methodology has been revised to remove the use of Trailer Suction Hopper Dredger. Backhoe dredging is now the preferred method, with operational hour assumptions extended to either 16-hour or 24-hour working periods and both options have been considered in the analysis presented below.

In addition, this addendum includes an assessment of dredge disposal at the Port Ellen disposal site (MA030). The disposal activity assumptions align with those used in the sediment dispersion modelling[1], whereby the hopper barge is assumed to discharge dredged material over a 10-minute period, with the initial discharge occurring 3 hours after dredging commences. Subsequent disposal events occur at two-hour intervals. As dredge disposal activity is directly influenced by the backhoe dredging working period, the predicted exposure levels vary depending on the assumed operational hours of the backhoe dredging activities.

Table 2-1 shows the updated construction information for backhoe dredging and dredge disposal.

Table 2-1: Updated and new marine construction information and predicted source levels for the EIA addendum

Activity	Working hours	% on-time	Source Plant	Source of underwater data	Source type	Lrms at 1m (dB re 1µPa)*	SEL 24hr at 1m (dB re 1µPa^{2}s)	Lpeak at 1m (dB re 1µPa)
Dredging with backhoe	07:00 - 19:00 (Previous assumption)	100% (12h/day)	Manu Pekka Backhoe Dredger	Diane Jones et al. (2015) Underwater Sound from Dredging activities: Establishing source levels and modelling the propagation of underwater sound, Table 5. Type of excavator: Boskalis BK2820D, Dredging depth: 18.6m, Bucket capacity: 14m^3	Continuous	163	209	---
Dredging with backhoe	07:00 - 23:00 (New assumption 1)	100% (16h/day)	Manu Pekka Backhoe Dredger	Diane Jones et al. (2015) Underwater Sound from Dredging activities: Establishing source levels and modelling the propagation of underwater sound, Table 5. Type of excavator: Boskalis BK2820D, Dredging depth: 18.6m, Bucket capacity: 14m^3	Continuous	163	211	---
Dredging with backhoe	24 hrs (New assumption 2)	100% (24h/day)	Manu Pekka Backhoe Dredger	Diane Jones et al. (2015) Underwater Sound from Dredging activities: Establishing source levels and modelling the propagation of underwater sound, Table 5.	Continuous	163	212	---

[1] Volume 3 Technical Appendices E.1 Dredging and Sediment Dispersion Modelling Report

Activity	Working hours	% on-time	Source Plant	Source of underwater data	Source type	Lrms at 1m (dB re 1µPa)*	SEL 24hr at 1m (dB re 1µPa^{2}s)	Lpeak at 1m (dB re 1µPa)
				Type of excavator: Boskalis BK2820D, Dredging depth: 18.6m, Bucket capacity: 14m^3				
Dredge disposal (New activity)	07:00 - 19:00 (previous assumption)	100% (16h/day)	Releasing of dredge material from split hopper barge	Dickerson C., Reine K J. & Clarke D.G. (2001). Characterization of underwater sounds produced by bucket dredging operations. USAERDC, DOER Technical Notes Collection ERDC TN-DOER-E14. Peak SPL (dB rms) measured 316m from split hopper barge is 108.7 dB re 1µPa at 45.8 Hz.	Continuous	154 @ 46 Hz	189 @ 46 Hz	---
Dredge disposal (New activity)	07:00 - 23:00 (New assumption 1)	100% (16h/day)	Releasing of dredge material from split hopper barge	Dickerson C., Reine K J. & Clarke D.G. (2001). Characterization of underwater sounds produced by bucket dredging operations. USAERDC, DOER Technical Notes Collection ERDC TN-DOER-E14. Peak SPL (dB rms) measured 316m from split hopper barge is 108.7 dB re 1µPa at 45.8 Hz.	Continuous	154 @ 46 Hz	190 @ 46 Hz	---
Dredge disposal (New activity)	24 hrs (New assumption 2)	100% (24h/day)	Releasing of dredge material from split hopper barge	Dickerson C., Reine K J. & Clarke D.G. (2001). Characterization of underwater sounds produced by bucket dredging operations. USAERDC, DOER Technical Notes Collection ERDC TN-DOER-E14. Peak SPL (dB rms) measured 316m from split hopper barge is 108.7 dB re 1µPa at 45.8 Hz.	Continuous	154 @ 46 Hz	192 @ 46 Hz	---

* L_{rms} at 1m were calculated with propagation loss coefficient of $\beta = 18$ to determine the source level

2.3.3 Model assumptions and limitations

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 2.3.3*.

3 Underwater noise assessment results

This section presents the impact distances arising from the identified acoustic thresholds.

3.1 Static receptors

The impact distances for new and updated construction activities are presented in Table 3-1. Due to bathymetry and intervening ground, the distance from the source to reach a threshold level varies with bearing. The maximum distance corresponds to the bearing with the lowest propagation loss and the average distance is the mean across all bearings. The results for all other activities presented in *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 3.1*, such as vibropiling of 700 mm sheet piles, vibropiling of 900 mm and 1200 mm tubular piles, and rock-socket piling remain unchanged.

Table 3-1 Effect risk versus distance for fish and predicted average and maximum (in brackets) PTS, TTS and disturbance distances for static marine fauna – continuous sound for new and updated construction activities

	Continuous Sound														
	Dredging with backhoe (16 hrs)			**Dredging with backhoe (24 hrs)**			**Dredge disposal (12 hrs)**			**Dredge disposal (16 hrs)**			**Dredge disposal (24 hrs)**		
	SEL_{24h} dist (m)		**rms dist (m)**	**SEL_{24h} dist (m)**		**rms dist (m)**	**SEL_{24h} dist (m)**		**rms dist (m)**	**SEL_{24h} dist (m)**		**rms dist (m)**	**SEL_{24h} dist (m)**		**rms dist (m)**
	PTS	**TTS**		**PTS**	**TTS**		**PTS**	**TTS**		**PTS**	**TTS**		**PTS**	**TTS**	
Fish groups															
No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low		(N) Moderate	(N) Low (I) Low (F) Low		(N) Moderate (I) Moderate (F) Low	(N) Low (I) Low (F) Low		(N) Moderate	(N) Low (I) Low (F) Low		(N) Moderate	(N) Low (I) Low (F) Low		(N) Moderate (I) Moderate (F) Low

	Continuous Sound															
	Dredging with backhoe (16 hrs)			Dredging with backhoe (24 hrs)			Dredge disposal (12 hrs)			Dredge disposal (16 hrs)			Dredge disposal (24 hrs)			
	SEL_{24h} dist (m)		rms dist (m)	SEL_{24h} dist (m)		rms dist (m)	SEL_{24h} dist (m)		rms dist (m)	SEL_{24h} dist (m)		rms dist (m)	SEL_{24h} dist (m)		rms dist (m)
	PTS	TTS		PTS	TTS		PTS	TTS		PTS	TTS		PTS	TTS	
			(I) Moderate (F) Low						(I) Moderate (F) Low			(I) Moderate (F) Low			
Marine mammal groups																
LF	<10 (<10)	150 (290)	240 (830)	20 (20)	160 (370)	240 (830)	---	---	260 (370)	---	---	260 (370)	---	---	260 (370)
HF	---	30 (30)		---	30 (40)		---	---		---	---		---	---	
VHF	---	50 (60)		<10 (<10)	60 (70)		---	---		---	---		---	---	
PCW	<10 (<10)	80 (100)		<10 (<10)	90 (120)		---	---		---	---		---	---	
OCW	---	30 (30)		---	30 (30)		---	---		---	---		---	---	

3.2 Fleeing receptors

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 3.2*.

4 Assessment of results

4.1 Marine fauna overview

4.1.1 Marine mammal overview

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.1.1*.

4.1.2 Fish overview

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.1.2*.

4.2 Construction activities overview

4.2.1 Piling

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.2.1*.

4.2.2 Vibropiling and rock socketing

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.2.1*.

4.2.3 Impact piling

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.2.3*.

4.2.4 Cardox and rock breaking

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.2.4*.

4.2.5 Backhoe Dredging

For marine mammals, the most sensitive hearing group affected by backhoe dredging is Low Frequency (LF) cetaceans. The maximum ranges for temporary threshold shift (TTS) are estimated at 290m for a 16-hour period and 370m for a 24-hour period. For permanent threshold shift (PTS), the corresponding maximum ranges are 10m and 20m respectively. Behavioural disturbance from backhoe dredging is assessed using the Lrms metric[2], which is not dependent on the exposure duration. Hence, the predicted disturbance range remains consistent with the previous technical appendix at 830m.

For fish without swim bladder, eggs and larvae, in the absence of a numerical threshold, PTS and TTS impacts are generally considered *low* within tens to hundreds of metres from the source. The exception is TTS in fish without swim bladders, which is assessed as *moderate* within tens of metres.

[2] The logarithmic measure of the root-mean-squared sound pressure relative to the reference sound pressure of 1µPa in water. Typically used to characterise continuous, non-impulsive noise.

4.2.6 Dredge Disposal

Measurements reported in Dickerson *et al.*, 2001[3] indicate that dredge disposal noise is dominant at 45.8Hz. At low frequencies, all marine mammal hearing groups exhibit low auditory sensitivity. Hence, noise model predicts that PTS and TTS is unlikely to arise from dredge disposal activities. The behavioural disturbance threshold is defined using Lrms, a broadband metric that does not account for the frequency-dependant hearing sensitivity of marine mammals. While the assessment predicts a potential disturbance range of up to 370m from the disposal site (MA030), it does not consider the low frequency nature of the noise, the limited number of daily disposal events, or the presence of existing harbour noise sources to which marine mammals are often habituated. When these contextual factors are considered together, the likelihood of disturbance in the context of the existing harbour noise sources is low.

For fish without swim bladder, eggs and larvae, in the absence of a numerical threshold, PTS and TTS impacts are considered *low* within tens to hundreds of metres from the source. The exception is TTS in fish without swim bladders, which is assessed as *moderate* within tens of metres.

4.2.7 Cumulative

It is anticipated that backhoe dredging will be undertaken in parallel with dredge disposal. Cumulative PTS or TTS effects are considered unlikely, as the disposal site (MA030) is located approximately 1km from the dredging location.

Potential cumulative behavioural disturbance arising from these two construction activities is expected to be minimal. The disturbance zones associated with dredging and disposal only overlap at a small area, and dredge-disposal events occur for approximately 10 minutes every 2 hours. Any simultaneous exposure would be brief and intermittent.

The cumulative assessment of all other construction activities remain unchanged from that presented in *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.2.6*.

4.3 In-combination effects

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 4.3*.

5 Mitigation

5.1 Construction

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 5.1*.

5.1.1 General Site Measures

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 5.1.1.*

[3] Dickerson C., Reine K J. & Clarke D.G. (2001). Characterization of underwater sounds produced by bucket dredging operations. USAERDC, DOER Technical Notes Collection ERDC TN-DOER-E14

5.1.2 Site Specific Measures

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Section 5.1.2*.

6 Conclusion

This addendum, based on outputs from the dBSea acoustic modelling, identifies the distances at which PTS, TTS, and behavioural disturbance are expected to occur from the updated construction activities. These updates include extending backhoe dredging operations to 16-hour and 24-hour working periods, as well as introducing dredge material disposal at the Port Ellen disposal site (MA030).

Prediction results indicate that the maximum TTS range for backhoe dredging is approximately 370m for the LF cetaceans, while the maximum behavioural disturbance range extends to 830m. The behavioural disturbance range is unaffected by the extension of working hours, as the threshold for behavioural response is based on the onset of disturbance, rather than the duration of sound exposure.

For dredge disposal, PTS and TTS is not expected to arise due to the low auditory sensitivity of marine mammals at the dominant dredge disposal frequency, while the maximum disturbance range is predicted to be approximately 370m from the disposal site. Given the brief and intermittent nature of dredge disposal events, cumulative impacts arising from periods where dredging and disposal may occur simultaneously are considered unlikely.

Annex A presents additional PTS, TTS and disturbance noise-contour maps for backhoe dredging and dredge-disposal operations (refer to Figure A.14 to Figure A.16) for this technical addendum. The noise contours include LF and VHF cetaceans, which together represent the most sensitive marine mammal hearing groups to underwater noise. Additional contours for PCW are also included, as Harbour seal, a qualifying feature of the South-East Islay Skerries SAC (approximately 5.2 km from the work area) is present in the wider area.

A. Underwater noise contour maps

Figure A.1: Construction area and designated sites

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.1*

Figure A.2: Underwater contour maps – LF cetaceans – Continuous PTS

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.2*

Figure A.3: Underwater contour maps - LF cetaceans - Continuous TTS and disturbance

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.3*

Figure A.4: Underwater contour maps - LF cetaceans – Impulsive PTS

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.4*

Figure A.5: Underwater contour maps - LF cetaceans – Impulsive TTS and disturbance

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.5*

Figure A.6: Underwater contour maps – VHF cetaceans – Continuous PTS

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.6*

Figure A.7: Underwater contour maps - VHF cetaceans - Continuous TTS and disturbance

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.7*

Figure A.8: Underwater contour maps - VHF cetaceans – Impulsive PTS

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.8*

Figure A.9: Underwater contour maps - VHF cetaceans – Impulsive TTS and disturbance

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.9*

Figure A.10: Underwater contour maps – PCW – Continuous PTS

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.10*

Figure A.11: Underwater contour maps - PCW - Continuous TTS and disturbance

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.11*

Figure A.12: Underwater contour maps - PCW – Impulsive PTS

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.12*

Figure A.13: Underwater contour maps - PCW – Impulsive TTS and disturbance

No change. See *Port Ellen Terminal Development Appendix D.9: Underwater Noise Assessment Figure A.13*

Figure A.14: Underwater contour maps – LF and VHF cetaceans – Continuous PTS and TTS for extended backhoe dredging working hours

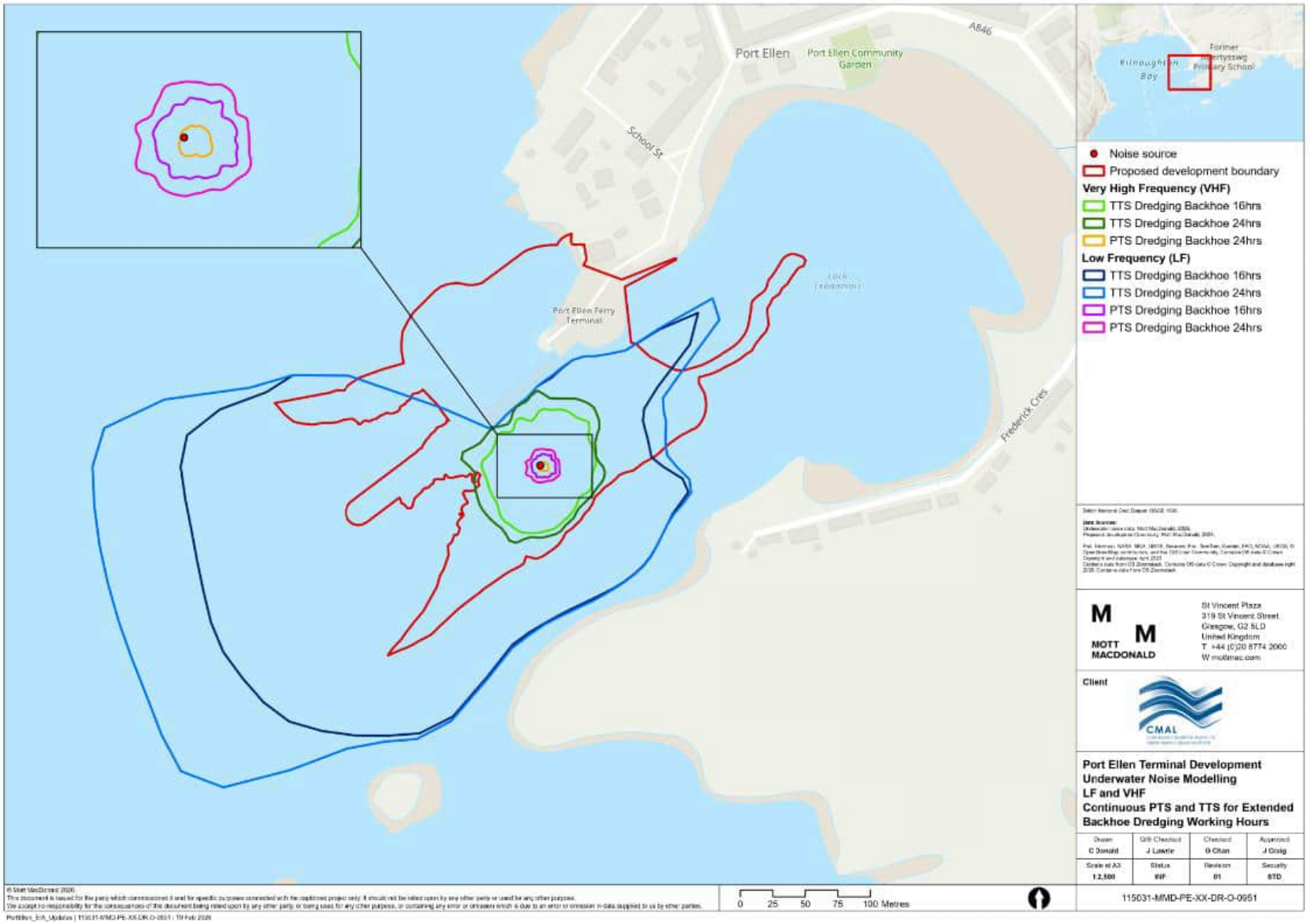

Figure A.15: Underwater contour maps - PCW cetaceans- Continuous PTS and TTS for extended backhoe dredging working hours

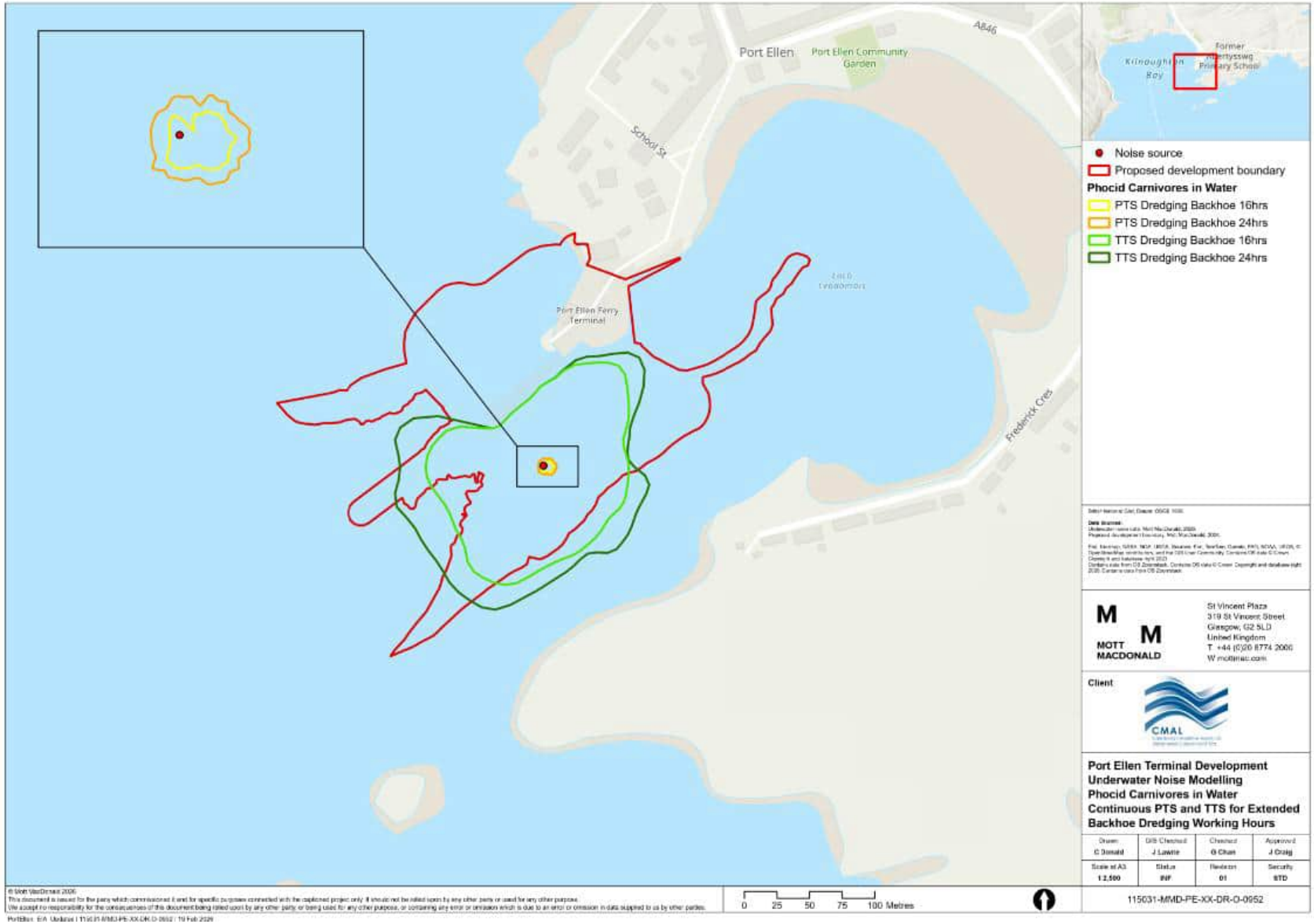

Figure A.16: Underwater contour maps – Disturbance for extended backhoe dredging working hours and dredge disposal